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ABSTRACT

TEACHING SUGGESTIONS FOR ENVIRONMENTAL EDUCATION IN JUNIOR HIGH SCHOOL GRADES ARE GROUPED UNDER FIVE GENERAL HEADINGS: "GEOLOGY," "WATER RESOURCES," "SOIL AND LAND USE," "TREES, WOODLOTS, AND FORESTS," AND "WILD-LIFE AND FISHES." LISTED UNDER EACH HEADING ARE ATTITUDES AND UNDERSTANDINGS TO DEVELOP, TOPICS FOR DISCUSSION, AND MANY SUGGESTED ACTIVITIES. ACTIVITIES REQUIRE STUDENTS TO MAKE OUTDOOR OBSERVATIONS, VISIT COMMUNITY FACILITIES AND NATURAL AREAS, AND USE REFERENCE MATERIALS. THE BIBLIOGRAPHY LISTS REFERENCES RELATED TO EACH OF THE FIVE GENERAL TOPICS, AND INCLUDES CHARTS, MAPS, BULLETINS, AND PAMPHLETS AS WELL AS BOOKS. (EB)

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ENVIRONMENTAL EDUCATION for JUNIOR HIGH GRADES

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A Teacher's Manual

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MICHIGAN DEPARTMENT OF NATURAL RESOURCES

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JUNIOR HIGH GRADES

Geology and Mineral Resources

ATTITUDES TO DEVELOP:

1. Review the learning goals listed for the intermediate grades. They are basic.
2. The use of mineral resources has given us our high standard of living and much of our leisure time.
3. It is essential that minerals be used with a minimum of waste because they are not renewable except through infinite time.
4. Be informed on the present reserves of certain critical minerals, such as iron, copper and petroleum.
5. Be informed on the distribution, present reserves and annual production of non-metallic minerals such as sand, gravel, gypsum, limestone, salt brines, etc.
6. Be informed on how and where metallic and non-metallic minerals are processed and the kinds of commercial products that result from such processing.
7. Knowledge of the transportation facilities and problems involved in our major mineral industries.
8. Knowledge of new and improved processes of extracting low-grade ores.
9. Mineral industries have contributed much to the economic and cultural history of local communities and to different geographic regions of the state.
10. New methods based on scientific research have made it possible to do a better job of managing and conserving minerals than was possible a few decades ago.

TOPICS FOR DISCUSSION:

1. Study and discuss the geological history of Michigan.
   a. Geologic periods: land, water, climate, plants, and animals.
   b. Inland seas.
   c. Glaciers that invaded Michigan.
   d. Glacial history of the Great Lakes.
   e. The work of glaciers.
   f. Topography and land forms.
   g. Rock formations and outcrops.
   h. Minerals and soils, lakes and streams.
2. Discuss glacial features of your community and explain the history and physical characteristics of moraines, kames, eskers, till plains, outwash plains, etc.
3. Study the geologic processes involved in the origin and deposition of important minerals: copper, iron, coal, petroleum, limestone, gypsum, gravel, salt, brines, etc.
4. Study the origin and history of (a) inland lakes, and (b) Great Lakes.

5. Discuss the discovery of copper and iron in Michigan.

6. Study the early history of copper mining in Michigan: Indian diggings on the Keweenaw peninsula and Isle Royale, the "Ontonagon boulder", and famous copper mines of the Keweenaw peninsula.

7. Discuss the contributions which Douglass Houghton, Edwin J. Hulbert, Alexander Agassiz, W.A. Burt, and P.M. Everett made to early minerological surveys and mining enterprises of the state.

8. Review the history of the Soo Locks and discuss the importance of the Sault canal and locks in the development of Michigan's industries.

9. Investigate and study newly developed processes of beneficiating low-grade iron ores which formerly could not be mined profitably.

10. Determine why we have laws which prohibit oil well drillers from abandoning a well without first plugging or casing the hole thoroughly. Discuss the relationship this has to water supplies.

11. How has geology affected your community? Its location and its industries?

12. Discuss the effects of the mineral resources of Michigan on the history of the United States.

13. Discuss the origin of the Great Lakes and their relation to United States history and economy.

14. Discuss: "The culture of North America is based on the use of its natural resources, its high standard of living, and the use of its mineral resources."

SUGGESTED ACTIVITIES:

1. Make a rock collection. Discuss their shapes and colors, as well as their mineral content. Determine which of nature's forces shaped the pebbles—wind, water, glacier.

2. Discuss the difference between the freshly broken rock and an old surface. What became of the worn-off rock?

3. Find a rusty piece of rock or a rusted pipe. Somehow the iron in the rock changed. To shop how, place a piece of iron in a dry place and another in a damp place. Watch them from day to day and see which weathers, "rusts", first. This is chemical weathering, as opposed to mechanical weathering (breaking up but not changing). Rusting is a union of the iron with the oxygen of the air, a very slow form of burning or combustion. Quick union of oxygen with metal causes an explosion. Flash bulb.

   Chemical weathering has been important in making our iron ore and our limestone, as well as our soil particles.

4. Locate a stone building, a stone foundation, boulder, monument in a cemetery. Discover evidences of, and kinds of, weathering.

5. Make a collection of stones illustrating the three classes of rocks—igneous, sedimentary and metamorphic. Make a chart or display showing how these rocks may be changed into other rocks by heat and pressure (limestone to marble, shale to slate). Show how these rocks break up into minerals by the agents of weathering (rain, wind, plants and animals, chemical changes) and become part of the soil.

6. Find fossil rocks showing evidence of an old sea. How did they get in the gravel pit? Discuss effects of glaciation and placement of the gravels. Note vegetation in new and old parts of pit. For what is the gravel used?

7. Make a map showing the mineral localities of Michigan and draw lines from the localities to your town showing what Michigan minerals are used by industries of your community. Make a similar map showing how your community depends on the United States as a whole.

8. Collect articles of copper, silver, iron, aluminum, magnesium, lead, tin, etc. for display. Study the background and the uses of the various metallic minerals. Which metals come from Michigan?

9. Visit an oil well, a quarry, a mine shaft, a gravel pit, a sand pit, if any of these are near your community. Perhaps the person in charge will allow you to take samples back to your classroom.

10. On a field trip, carry a map and locate various glacial features, such as moraines, till plains, outwash plains, gravel deposits. Account for the many different rocks and soil types found in a small area. Discuss good uses of the glacial deposits.

11. Make a large map of the county, showing important geological features such as streams, direction of stream flow, lakes, general moraine, ground moraine (till plain) areas, and outwash plains. Avoid having the map become too intricate. Note relation of agriculture or other land use to the geological formations. Note the relationship of ecology and geology.

12. Visit a stream. Note the direction of the current; the character of the valley. Notice the position of cutting on the banks and where sands or gravels are being deposited. Discuss how stream improvement practices change direction of currents, create better fish habitat, control bank erosion. Man copies nature when he makes stream improvements.

13. Visit a lake at various seasons of the year to observe important geological changes that take place. Note the effect of the ice on the shore line, plant growth in the lake; wave action, and other effects.

14. Visit a gravel pit. At its edge, find the depth of the topsoil. Note whether the gravel is found in layers showing the action of water in sorting materials, or whether it is unstratified (generally mixed up). Notice whether the gravel is fine or coarse. Notice whether or not water is in the bottom of the pit. If so, this is probably the water table of the surrounding area. Where did the water come from?

15. Determine if local water use has bad features and set up a plan for better use. Do you know of any companies that have solved pollution problems by finding a use for waste that formerly polluted streams or ground water? Discuss industries that have made use of waste in your community and elsewhere; i.e., brine waste from salt wells, (Dow, Wyandotte and other chemical plants), waste from petroleum wells. Use of waste makes wealth.

16. Outline the history of your town. What influenced its location? What were its first industries? What are its industries now? Why the change? Discuss the part, if any, played by minerals in the change. Determine if the local water supply had anything to do with industries coming to, or moving from, your town.

17. Write stories comparing the minerals used in Civil War time and today. Only seven minerals were in common use when America was discovered. Only 14 were common in 1900. Today, we use over 50 minerals.

18. Investigate the source of your community's water supply. Find out the amount used per capita per day. List all the uses of water in your home and community. Have each pupil determine how water has been of value to him in one day.

19. Discuss causes of water pollution. Both ground water and surface water can be, and are, polluted in some areas. Discuss methods of remedying water pollution. Discuss the disposal of industrial wastes in your community.

20. If local water supplies are from individual wells, map your community to show well depth and quality. Include the amount pumped from each well per day.

21. Visit an oil field if possible. Find out what type of rock is most likely to yield oil. Write the fascinating story of how oil came to be in the rock and the relationship between old seas that covered the state and the plants and animals that lived in them.

22. Find what laws we have regarding the flow from an oil well and why they are good laws.

23. Determine why a law was written to prohibit oil well drillers from abandoning a well without first plugging or casing the hole thoroughly. Investigate the relationship this has to a water supply.

24. Prepare reports on the various minerals found in the state. Bring out economic and social significance of the discovery and the processing of these minerals.

25. Write stories of the origins of all mineral resources of Michigan. Make maps and charts to show how these resources have been developed.

26. Discuss and chart the uses of water in agriculture, manufacturing, recreation, transportation and for domestic purposes. In the same way, discuss and chart the uses of iron, copper, salt, bromine, gypsum, gravel, limestone. Did primitive man use any of these resources?

27. Look in the advertising section of any magazine. List those advertisers whose businesses depend directly on use of minerals. List those industries to which a geologist is of value.

28. How has geology——earth history——affected your community? Its location? Its industries?

29. List the mineral resources mentioned on the financial page of your paper.

Water Resources

ATTITUDES TO DEVELOP

1. Water should not be considered as an enemy——it is our best and most important friend and is necessary to us in a great many different ways.

2. The quantities required are enormous.

3. The quality must meet certain standards.

4. The available supply in Michigan is not lessening except by pollution and rupture of artesian caps.

5. Demands for available water are steadily growing - faster in some places than others.

6. Water conservation is a public problem. It requires community interest and action. Citizenship.

7. Water conservation is wise use——the specific activities in any place must be determined on the basis of what uses are desired.

8. Water conservation is inescapably tied in with land use practices.

9. Search for water is the work of the student of water and earth history -- the hydrogeologist. Getting water to the consumer is an engineering problem.

TOPICS FOR DISCUSSION:

1. From where does water come? Discuss clouds, rain, snow, wind. Discuss movement of water from ocean, lake, river, or any body of water into the air.

2. Where does water go when it reaches the earth? Does it go into an underground lake or river? Disucss porous rock, subsoil and soil. Only in limestone regions do we have underground lakes and rivers. Define ground water reservoir.

3. Discuss the different kinds of domestic water uses for one day, the quantities used in each and total consumption. How much water does the average household use in a day? In a year?

4. Study the school water supply. If it is a well, learn the pump's capacity.

5. If a municipal water system supplies the school, obtain water bills from superintendent's office and compute the per capita use.

6. Measure loss of water from leaky faucets. Compute annual loss. Estimate loss from leaky toilets.

7. Study and discuss water-borne diseases.

8. Hold a class discussion on pleasant things associated with water (e.g., a cool drink, camping, skating, snowballing, rainbows, coffee perking, fishing, rain, waterfalls, a warm bath, air conditioning, ice cream sodas, sea stories, playing with water in a sand box, clean clothes, watermelons, speed boat rides, steam heat, electricity, frost.)

9. Consider ways in which enjoyment of the listed uses could be interfered with. Note: pupils will readily identify ways in which the resource itself might be injured. However, note also such less obvious but important things as public access, price, local availability, leisure time to enjoy, preservation and improvement of environment, frame of mind to appreciate, educational background to understand and use wisely. Discussion might lead to or fit in with consideration of citizenship, American way of life, anti-vandalism, anti- communism.

10. Discuss historic events which have been influenced by water (navigation, drought, isolation, power, mining, irrigation, etc.).

11. Study poetry, literature, dealing with water. Have students give five-minute talks on phases of water which interest them. Also, prepare essays, stories, and descriptions.

SUGGESTED ACTIVITIES:

1. Make drawing of the hydrologic cycle. How does water get out of the ground? How does man get it from the ground? Do plants take water from the ground? Cover a small plant with a dry tumbler. Explain what happens in a day or perhaps a few hours. Where does the water go that evaporates?

2. Obtain several 8-oz. clear glass tumblers. Fit a fine mesh screen half way from the top of the tumbler. Place two inches of sand on the screen in one tumbler, two inches of fine gravel in another, two inches of coarse gravel in another, and two inches of clay in another. Fill the tumblers with water. Discuss what happens. (A piece of fine crash cloth pushed into the tumbler like a sack and held in place by a rubber band will serve if screening cannot be obtained.) Discuss screens in wells. Discuss capillary movement of water——may be a part of a physiology or osmosis experiment also.

3. Get pieces of sandstone, marble, slate, shale, granite. Submerge each in water to 1/3 its largest dimension. Discuss the activity of water in relation to each rock. Discuss sand in relation to ground water.

4. Make a rain gauge and collect rainfall records for a month or more. At end of period, call on nearby U.S. Weather Bureau observer and see how your record compares with his. Obtain record of past years from U.S. Weather Bureau, East Lansing, and note variation from place, year to year, month to month. An upright tin can can serve as a rain gauge. It is preferable that the can be fairly large, say 6" to 10" in diameter. Such cans may be obtained at any gas station. For accurate results, the top edge should be reasonably sharp and smooth. Since it is difficult to measure light rainfall directly, a funnel arrangement in the bottom of the can directing the water into a can of substantially smaller diameter is helpful. Thus, if the large can is 8" in diameter and the small can 2", an accumulation of 4" in the small can would represent ¼" of rainfall. (Ratio of radius squared.) A few drops of light oil may be put in the small can to prevent evaporation. The gauge can be secured in a light wooden frame and fastened to a low post or platform at a distance from trees or buildings equal to the height of the trees or buildings. The frame should not reach to the top of the large can. Why?

5. Set up illustrative computations——how much water in ¼" of rain on one acre? What flow in a stream draining ten square miles to carry away water from a 2" rain in 24 hours, allowing 20% runoff, 40%, 80%? How much rain and snow falls on a city lot 50' x 150' in a year's time at 25", 30", 35"? How long would one have to sprinkle a lawn 50' x 40' to equal the water in a ½"rain, if the hose flows two gallons per minute? 4 gallons per minute? (Civics, history, math.)

6. A very effective snow sampler consists merely of a length of 4" stove pipe which may be pushed down through the snow, and when lifted, will bring up a cylinder of snow. Take a yardstick and measure snow depth at many places. Collect several samples at sites of average depth. Put in a pail together, melt, measure volume, divide by number of samples used and number of square inches in stove pipe opening. Result is inches of water represented by snow on the ground. This can be tried several times during the winter with interesting results.

7. Raise potted farm plants——potatoes, corn, tomatoes, wheat, beans, etc. Keep accurate records of water used. From results, compute water requirements per acre in inches, in gallons. Note: Results will become most significant after plants have reached an appreciable size. After experiment is finished, cut and dry the plants. Compute water use per pound of dry material. This study could be combined with experiments on soils and fertilizers.

8. Make a glass-sided terrarium with landscape. Build a sloping base of fine gravel or coarse sand, covering all but upper portions with soil. Shape soil into sloping fields. Simulate contour farming, sod waterways, forestation of steep slopes, terraces, gullies. Leave outlet hole in terrarium at low end of "land". Introduce water in exposed gravel at upper end. Simulate rivers, artesian wells, springs, by regulating flows. (Won't guarantee results from this project——likely to be too difficult, although some students might make it a real show.)

9. Collect stream bottom life (insect larvae, crustaceans, shellfish, minnows, etc.) and maintain a native aquarium. If done in late spring, hatching of dragon flies, mayflies, stoneflies might be observed. (See Wildlife Activities.)

10. Prepare water conservation posters. Collect scenic photos of water resources.

11. Plan an ideal lakeside or streamside park (or build a model) with ideal water and land conditions. Plan an ideal tourist cabin area making best use of local water resources. Consider everything you would want if you were the tourist.

12. Determine from local inquiry and observations the local water problems.

13. Check the items in a daily newspaper, farm magazine, contractors' magazine, news weekly, to see how many items deal with water. Prepare an exhibit of such items. See how many different water uses or problems they deal with.

14. Weigh an apple, a potato, a cluster of lettuce leaves. Bake to dryness and reweigh. Compute water percentage.

15. Observe lime or iron deposits in tea kettle, cooking utensils, fountains, sinks, etc., in steam and water pipes, on wellscreens.

16. Shake up bottles of water containing sand, clay, marl, silt, mixed soils. Observe time it takes to settle out. Compute distance material could have traveled in that time in a stream at ordinary flow rates——2 or 3 feet per second.

17. Visit a municipal water treatment plant and:

    a. Find out where water comes from, how it is treated (chlorinated, softened, iron removed, etc.), and how it is distributed.

    b. Learn what it costs, how many people are employed in providing your water supply, what they do, how much water is supplied by the plants, how the demand varies during the day and the year, how the demand is growing, whether new sources are planned or if the present source is adequate. (Use also in arithmetic classes.) Map location of water mains. Inquire about the estimated maximum demand for fighting fires.

    c. Find out what problems confront your water supply department, what breakdowns occur, how long the supply can be cut off for repairs, what effect prolonged shutdown has on industry, domestic supply. For social studies, inquire who the big water users are and what they use water for.

    d. See if your water situation is an asset to attract industry and other revenue-producing enterprises and whether citizens give the necessary support to water department in development of best possible supply.

    e. Ask how deep are wells (if any), how cold is the water, how are water levels behaving. Ask to see well drilling samples. (See Geology Activities.) Inquire whether State Health Department endorses the system, whether assistance of State Geological Survey has been obtained in appraisal of local ground water resources.

    f. Find out financial situation of water department. Learn what are the big cost items in operation, maintenance, repair. Determine whether water is available to every house in city. Are all connections metered or is there a flat charge?

    g. Ask to see State Health Department's reports on water samples. Have them explained. Are the reports ever unsatisfactory? What is the quality of the water (if not treated), how hard? How much iron? How much money would be saved by housewives on soap if water was softened?

    h. When were water systems improvement proposals last before the city government? Who proposed them? If not the water department, what did it propose? Who voted against the improvement? Why? (social studies and civics)

    i. Is Fluoride added to supply to prevent tooth decay? If so, for how long? If not, has it been proposed? Why turned down?

    j. Are there any sources of ground water pollution near the municipal wells? Any industrial waste disposal pits? What is the waste? Does the State Health Department know about them? County Health Department? If the water comes from a lake or stream, how clear is it? Any pollution from upstream? If so, what is being done about it? What type of filter is used? How backwashed?

    k. View the motion picture, "The River Grand", available from the Department of Natural Resources, Lansing.

l. Is the water department self-supporting? Are its revenues used to assist in the financing of other city departments? How are water main extensions financed? Have the water rates been increased within the last two years? Did the residential user bear the brunt of this rate increas? Or, did large consumers, the commercial and industrial users, share?

18. Visit a municipal sewage disposal plant, and:

a. Is the sewer system a separate or combined collector? If a combined system, how is storm runoff handled? Are diversion chambers used? Are they automatic in operation? What lake or stream receives this storm flow?

b. What type of treatment is employed at the treatment plant? Are present facilities adequate to handle the average daily flow of sewage? Has the sanitation department considered future needs of the city for treatment? Has consideration been given or are plans being prepared for additions or a greater degree of treatment?

c. Has your city always taken a progressive attitude in regard to providing adequate sewage treatment facilities or has the State of Michigan had to force the issue to provide proper treatment?

d. How were the present facilities financed? Does your sanitation department operate on the more modern self-supporting utility plan or are operating and maintenance expenses paid from the taxes collected?

e. Other than residential sewage, what are the major contributors of sewage to the system? Do any industries contribute wastes which are difficult to treat or place a heavy load on the plant? How effective is the treatment plant?

f. What percentage of Bio-chemical oxygen demand and total solids is removed? If either is below 90%, ask why.

g. Does the plant effluent (treated sewage) discharge to a lake or stream? Does this cause any damage to the receiving waters? Is this final effluent chlorinated to protect downstream users or possible bathing facilities nearby? Do any municipalities down river use the receiving stream for a public water supply?

h. Is the Michigan Department of Public Health satisfied with this plant's operations? If not, what do they believe needs improvement? Is the entire city served with sewers or are parts without service? Are sewer extensions paid for entirely by assessments or is a portion of costs paid by the city at large?

19. Visit the fire department, and:

a. Ask for information about water-using equipment. How many hoses? What is the capacity of one hose? How much water per minute for a big fire? Does the pressure hold up? How much storage does the municipal system have? How fast can it supply water after the storage is gone?

b. How many fire hydrants in the city? How close together? What size mains do they connect with? How are they protected in winter?

c. If two fires break out at the same time, is there enough water to handle both? To handle auxiliary trucks brought in from other towns? Does the fire department go out of the city to fight suburban or rural fires? Do they find enough water to fight fires at those places?

d. How should homes outside the city prepare for fire fighting? How important is it to get water started on a fire immediately? Can a few extra outlets equipped with garden hoses help much? Where should the water be sprayed? Are most rural and suburban systems as big as they should be for fire fighting?

e. Where is the hydrant closest to your school? How quickly could the fire department come after an alarm? (math, geography, history, English)

20. Arrange with a farmer for a field tip to study water problems on a farm.

a. What is the source of water supply? If wells, how many? How deep? What capacity? Explain pumps. Electric or gasoline? If electric, is there an auxiliary source for emergency?

b. How much water storage in system? How long could farms get along without water? How much water does it take per cow per day? Is water piped to barn? Does adequate inside supply improve milk production?

c. What is the source of water for the pasture? If stream, does it ever fail? Is it polluted? Have cattle ever died from drinking it? Is anyone using it for irrigation yet?

d. Has the farmer ever had occasion to inquire into his water rights? Is water source adequate for present? Are plans being considered to increase supply?

e. Does drought cause much loss? About how frequently is drought a problem? If irrigation is being practiced, what is source? How long has system been in operation? Has it paid? Is continued or additional irrigation proposed? How much water does system take? What rate of pumping? How many acres being irrigated? What crops? Is source dependable? Are others likely to require that the source be shared?

f. How about fire fighting? Are outlets readily available? Hoses? Is system adequate? Pressure? How long would it take fire department to reach farm after alarm? What could be done to control fire while waiting for fire department? Are farm buildings and contents insured for full value?

g. Has domestic supply been tested for bacteriological purity? How recently?

h. How is gasoline, kerosene, fuel oil stored? Any history of leaks? Any other possibility of bad tasting or poisonous materials entering ground? How near to well? How long have these been there?

i. How close is sewage disposal system to well? Upslope or downslope from well? Any nearby industries dumping waste onto ground? How long? Which way do wastes move after entering ground?

j. Have any fields required drainage? How close together are tile drains? How deep? Do they work satisfactorily? Is further drainage necessary? Planned? Are outlet drains adequately maintained? How was design of tile fields and outlet drains made?

k. Does the farmer practice soil conservation? What is involved---contour farming? Grassland farming? sod waterways? terracing? Are there any gullies on farm? Siltation of drains? streams?

l. Is there a farm pond? Is there one planned? If one exists, what use does it serve? stock water? fishing? spray water? scenic beauty and property value enhancement?

m. Any reforestation of light soils? steep slopes? Are cattle fenced away from river to prevent bank erosion except at selected watering sites? Have banks been planted to shade water? attract wildlife?

n. Do farm boys trap muskrat or mink? hunt ducks? fish? swim? Are farms or nearby facilities for these activities improved? Any plans for improvement?

o. Is public permitted to use farm waters for hunting, fishing, swimming, etc.? If so, do they respect farmer's property and rights? If not, would farmer admit public if he were sure it would respect his interests? Has local municipality ever approached him on making his water facilities available? Has local sportsmen's club?

p. Does farmer feel that water rights legislation is needed to protect his future welfare? Does he think state should take an active part in water conservation?

21. Water for industry.

a. List industries in your town. For each industry, apply following:

b. What is water source? Is it adequate: If own wells, how deep? What diameter? What capacity? Any trouble with wells? Any improvements planned? Is quality satisfactory?

c. If water supply comes from a lake or river, is source dependable? Pure? Do water levels cause trouble (flood or drought)? If municipal, is source adequate? Can supply be increased?

d. How is water used in industry? How much does it cost? Would more water be of value? Is a better quality needed? Lower temperature? How does the industry add to the welfare of the community? If supply failed what effect would it have on industry?

e. If industry had to move, would water supply be important in the selection of its new location?

f. Does industry have a waste disposal problem? Has the industry solved its own problem? How? Has it been called before Water Resources Commission? Put under order to control pollution? How much is waste treatment costing? Explain problem and methods of control. Has the industry profited financially by its method of waste disposal?

g. What harm would, or do, wastes do——kill fish? harm livestock? impart taste or odor? cause deposits in stream bottom? harm waterfowl? contaminate ground water?

h. If dumped on the ground or in pits, what happens to waste? Can it mix with ground waters? Which way does it move? How is this known? Verified by state?

i. What is the trend in water use? Estimated needs five years from now? 25 years from now?

22. Parks and picnic grounds

a. Visit local water-side recreation areas. Analyze them carefully. Now do they differ from the best of which students know? Are they as good as possible? Could they be improved? How?

b. Could wading and swimming be better than it is? Is the water dirty? Where does the dirt come from?

c. Is the area readily accessible? safe? attractive?

d. Has the community ever carefully studied how it could be put into greatest usefulness? Does your community have all the water-side recreation facilities it needs? Is water-side recreation important to your community for enjoyment of residents? For attraction of tax-producing, job-making industries?

e. List the advantages to your community, to your school, and to you personally of public improvement of local water sides such as brooks, rivers, ponds, lakes.

Soils and Land Use

ATTITUDES AND UNDERSTANDINGS TO DEVELOP:

1. Soils are derived from rocks. When rocks are broken down by the weathering forces of rain, heat, freezing temperatures, and wind, the eroded rock particles constitute the parent material from which soils are derived.

2. Soils in any area are not necessarily derived from the bed rock over which they lay because weathered rock particles can, and frequently have been, moved hundreds of miles by water, wind, and glaciers. Thus, soils derived from sandstone or granite have been deposited over limestone or shale and vice-versa.

3. The texture and fertility of soils differ depending on (1) the parent material from which they came, (2) the further weathering of the parent material resulting in the release of the soluble elements essential for plant growth, and (3) the accumulation of humus derived from the decay of plant and animal materials.

4. Factors involved in soil formation are parent material, topography, climate, living organisms, and time.

5. As soils age and mature, they develop characteristic profiles consisting of layers (or horizons) which differ in texture, color, and fertility depending on the nature of the parent materials from which they are derived.

6. Soils can be classified on the basis of their profiles.

7. There are many types of soil in Michigan which differ in physical structure, appearance, and productivity. Some are suitable for growing agricultural crops, others are not suitable for cultivation.

8. Soils can be improved by good management or husbandry, but they can also be destroyed by carelessness and neglect.

9. Land is not only soil; it is lakes, rivers and vegetation, and is affected by climate topography.

10. Every tract of land, regardless of its size or location, should be studied and classified to insure that it is put to a use that will benefit society as well as the owner or owners.

11. All life, both plant and animal, is dependent on the fertility of the soil.

12. America cannot be proud of many things that have been done to the land. Some land has been cleared and farmed that should have remained in forests or grasses; and much land has been depleted and made barren by misuse and erosion.

TOPICS FOR DISCUSSION:

1. Discuss the formation of soil by weathering, ageing, leaching, and accumulation of humus.

2. Duscuss the effects of glaciers on the soil types of Michigan.

3. Compare the water holding capacity of different kinds of soil——clay, loam, sand.

4. Discuss topsoil, subsoil, parent material, and soil profiles.

5. Of what importance is air and water in soil?

6. Discuss the living organisms that inhabit the soil and promote decay and the formation of humus--bacteria, fungi, worms, insects, etc. Read the Department's bulletin, "Life In The Soil".

7. Disucss methods of preventing soil from becoming unproductive due to the loss of soluble minerals.

8. List and disucss the chemical elements that are essential for plant growth.

9. Explore the use of commercial fertilizers and lime on agricultural land.

10. Discuss crop rotation, green manure crops, alfalfa, and other leguminous plants in improving soil texture and fertility.

11. Discuss the importance of trees, grass, weeds, and other vegetation in preventing soil erosion.

12. What is sheet erosion; How significant is it? Compare it with gully erosion.

13. Explain the meaning of contour plowing, strip cropping, sod waterways, terracing, etc.

14. Show film, "To Care For This Land", available from the Department of Natural Resources.

15. Find out how much land is taken out of agriculture, forestry, and other uses in each section (square mile) for the expressways. How much land in the state is sued for highways and secondary roads?

16. Is it good land use to take first class agricultural land out of production for subdivisions, factory sites, and other uses?

17. Debate the pros and cons of rural zoning.

18. Discuss the drainage of wetlands. What factors should be considered before undertaking a drainage project?

19. Is it legal for anyone (1) to build a retaining wall at some distance beyond the usual water line in front of his lakeshore cottage and fill in the intervening submerged land to extend his property out into a lake, (2) to build an earth-or rock-filled jetty out into a lake for boat dockage, or (3) to build a road across a swampy, shallow bay and thus reduce the size of a lake and destroy fish and wildlife habitat?

20. What is reparian ownership of land? What are riparian rights? Can a cottage owner on a lake exclude the public or neighbors from the beach in front of his dwelling? Can he exclude swimmers or boaters from the water in front of his cottage if they enter the water from their own or neighboring property?

21. What is a private lake or stream? Do regular game and fish laws apply in case of private lakes and streams?

22. Is a landowner liable for damages if a neighbor's child drowns in his swimming pool or on his private fish pond? Is a property owner liable for damages due to death or injury of a guest or a trespasser, who enters his property for hiking, picnicking, hunting, fishing, swimming, or other activity? Has this been an important factor in the past in limiting recreational opportunities on private lands in northern Michigan? In southern Michigan?

23. D iscuss the extent to which the local standard of living is dependent on soil productivity and wise land use.

SUGGESTED ACTIVITIES:

1. To illustrate what happens when a raindrop strikes bare earth, put some soil in a small baking tin. With an eye dropper, drop water from several feet above the tin onto the soil. Have the pupils watch to see the soil puff upward when the water hits it. Make a mound of this soil. Drop more water and see if any evidence of erosion takes place.

2. To illustrate runoff of a forest hillside compared to a bare hillside, use a piece of blotting paper and a piece of ordinary penmanship paper. Tip the two pieces of paper. Drop water on each. Notice how the blotter absorbs water (forested hillside) and how the water runs off smooth paper (bare hillside). Apply this to farming practices.

3. From your county agricultural agent or vocational agriculture teacher, find out what supplemental minerals are necessary in the soil to produce highest yield and quality of these crops: Corn, potatoes, sugar beets, alfalfa hay, and rye.

4. Procure a soil testing kit from your county agricultural agent or the Soil Conservation Service. Test samples of soil to see if the soil is acid or alkaline in content.

5. List all the uses of land other than farming.

6. Have the students collect soil profiles from their neighborhoods. Olive bottles may be used. Place a few inches of each type of soil in the bottle in the order they are found. A road cut is a good place to take samples.

7. Investigate by surveys or trips, the recreational opportunities of your county. Make a recreational map of your county. Locate state parks, recreation areas, state forests, national forests, public fishing sites, game areas, picnic grounds, county parks, etc.

8. Make posters and charts showing what happens to a raindrop from the time it strikes the ground until it falls as rain again. The story might be quite different under good soil conservation practices than under poor ones.

9. Collect pictures of types of farm machinery: Plows, discs, harrows, etc. Have the students tell what machines are used on their farms. Discuss how each affects the topsoil and what methods are best for the soil in your community.

10. Have students give reports on different types of farming, such as dairy farming, muck farming, fruit farming, other types. Relate type and kind of soil and other factors.

11. Are there any abandoned farms in your community or township? Visit an abandoned farm and look for evidences of why is was abandoned. Does the land have a history of tax delinquency? One of your township supervisors or some old resident of the neighborhood may be able to provide information.

12. Are there any tax delinquent lands in your community, township, or county? Trace the history of such lands from tax records in the county courthouse.

13. Become familiar with the various agencies producing materials and literature on soil conservation.

14. Interview old residents of the community about natural conditions when the community was first settled, or consult your local library about the early history of your community. Report to the class.

15. Obtain several flower pots which may be used for experimental purposes. Fill one pot with topsoil, one with subsoil, one with subsoil plus organic matter, and so on. Plant seeds in each; allow each to receive equal amounts of water and light. Keep records of the differences of growth and draw conclusions.

16. Bring to class several plants, including plants from row crops and others not cultivated. Compare root systems of the two groups and relate this to erosion control.

17. Plan a field trip to see examples of various types of soil and soil erosion. Include examples of various types of soil erosion control methods. Your County Extension Agent or one of the Directors of the local Soil Conservation District might be able to arrange the trip or tell you where to go.

18. Obtain information on the dust storms of the 1930's and present such information to the class. Read, "Deserts On The March", by Paul B. Sears.

19. Find out what percentage of soil is considered first class, second class, third class, and fourth class land. Relate this to the population of your county and employment opportunities. Draw conclusions.

20. Discuss and report on soil conservation activities in your community. Consult a Soil Conservation District Director or County Extension Agent.

21. Examine a square foot or smaller sample of topsoil to see what creatures live in it and the possible part they play in soil fertility. In this connection examine similar sized samples from a woodlot or forest, a meadow, and a cultivated field; compare results.

22. Find out to what extent poor land use has reduced land values in your community. Find out if good land use has increased tax evaluation. Township officials should be able to provide such information.

23. Discuss the implication of each of the following quotations:

    a. 1790--Patrick Henry: "He is the greatest patriot who stops most gullies."

    b. 1790--Washington: "Neither my overseer nor manager will attend to anything but the crops they have usually cultivated. They grow Indian corn whenever they can."

    c. 1817--Jefferson: "Fields are no sooner cleared than washed."

    d. Theodore Roosevelt: "When soil is gone, man must go."

24. Discuss ten losses resulting from soil erosion:

    a. decreased food production
    b. increased floods taking toli of life and property
    c. dust storms rendering areas unfit for use
    d. periodic crop failure
    e. decreased food for game
    f. muddy streams unfit for fish
    g. silted reservoirs rendering hydroelectric power useless
    h. decline of industries and decay of cities
    i. loss of plant food and added submarginal land
    j. bankrupt farmers, migrating populations, poverty, and decadence

25. Experiment with several types of soil in the community by:
    a. weighing each kind
    b. saturating with water
    c. reweighing
    d. determining which holds the most water

26. Trace the history of the desert areas of the world from Biblical times to our dust bowl.

Trees, Woodlots, and Forests

ATTITUDES TO DEVELOP:

1. Thorough understanding of how trees live, grow, and reproduce.

2. Develop idea that a forest is a "community" in which trees are dominant, and that the forest includes many kinds of plants and animals, all of which are interrelated.

3. Forests are not inexhaustible and must be protected from fire, disease, insects, and animals including man.

4. Forests, to be most productive, have to be managed; they are not essentially different from a farm in this respect since trees have to be propagated, protected, and harvested when mature.

5. Develop an understanding of all of the interrelationships of the forest environment——soil, water, land use, timber products, wildlife, recreation.

6. Develop a proper attitude toward multiple use of our forests.

7. Develop an understanding of social significance and economic importance of the forest, both in the history and the present economic status of the community in which you live, and of the entire state.

8. Forests temper climates. They retard the rapid runoff of water from melting snow or heavy rain and thus alleviate the danger of floods. Thus, they help maintain a more uniform flow of water in small and large rivers.

9. Forests prevent soil erosion from hills and mountainsides; and thus, they reduce the silt load carried by streams and the resultant damage to fishes and other aquatic organisms.

10. Forests have spiritual and recreational values as well as economic worth.

TOPICS FOR DISCUSSION:

1. Discuss the kinds of soil on which the following forest types usually grow; white and red pine; jack pine, white cedar and black spruce; elm; ash and soft maple; beech, hard maple and yellow birch; red and white oak.

2. Discuss and diagram the stages of forest succession beginning with bare areas (rocks or denuded soils), emphasizing the pioneer species of plants that invade barren areas, the plants that succeed the pioneers, the trees that will not reproduce themselves in their own shade, and the climax species of trees that will reproduce in shade. Also, emphasize the time involved in such changes and the influence of climate. Point out that successions of vegetation can be set back to the beginning by such disasters as forest fires, volcanic action, severe erosion, and other factors that destroy the top soil as well as the vegetation. Also, that man can retard succession by forest management.

3. Illustrate also the succession of vegetation that takes place in aquatic habitats and progresses through swamp-types of vegetation before attaining the climax forest type.

4. Discuss the vertical stratification of mature forest habitats: forest floor, shrubs and herbs, under-story trees, and forest canopy. What kinds of animal life are typical of each of these strata? Refer to "The Web of Life" by John H. Storer (Devin-Adair Company).

5. What is meant by "forest edge"? Wildlife has been found in greater abundance and variety in the forest edge than in the interior of dense forests. Why? Discuss the reasons for not planting trees in all open fields in a forest.

6. Look up information on the forest fires that occurred in Michigan in 1871, 1881, 1894, 1896, 1908, 1911, and in recent years. Have students present oral or written reports on these fires. Refer to Department bulletin, "Forest Fires and Forest Fire Control In Michigan".

7. Debate the question of whether forest fires following logging may or may not have benefitted wildlife, especially deer and snowshoe hares, in the long run.

8. What is meant by "controlled burning"? Under what circumstances is it justifiable? List the precautions to be taken in preparing for such a fire.

9. Do you have to have a permit to burn brush, fence rows, and weedy fields in your county? When and under what circumstances? Who would you contact to obtain such a permit?

10. What effect does burning fence rows, and weedy fields have on wildlife?

11. List the insects and diseases that do serious damage to forest trees. Is aerial spraying of infested areas justifiable considering the effect of DDT and other powerful esticides on wildlife and fishes of all kinds, including harmless and useful species? Assign reading from Rachel Carson's "Silent Spring" and articles on pesticides available from the Dept. of Natural Resources.

12. How does an over-population of deer or elk injure a forest? Has this occurred in Michigan? Refer to "Michigan Whitetails", by Bartlett and Jenkins, available in your school library and "The Choice We Face" available from the Dept. of Nat. Resources

13. Discuss how forests helped and hindered the early settlers of Michigan.

14. Discuss the various phases of logging operations.

15. What were log marks? Why were they important in pine logging?

16. Define these terms: Cant hook, peavey, roll - way, wannigan, river drive, log boom, booming site.

17. Discuss the history of the big wheels. Who invented them? How and when were they used? Where were they manufactured? How widely were they distributed? Refer to "Pine Days" available from the Dept. of Natural Resources.

18. What kind of trees were used for tanbark? Discuss the problems of tanbark logging. At what seasons were trees cut for tanbark? Why? How important was the industry?

19. When did pine logging begin in Michigan? When did it reach its peak? When did the sawmills begin to close down for lack of pine logs to saw? How many board feet of lumber was produced by the mills at Saginaw and Bay City or Muskegon during the peak year or years of production?

20. How important is logging in Michigan today? What species of trees are being cut for pulpwood, veneer, and plywood; chemical wood, charcoal briquettes, lumber for building?

21. Is timber being sold from state forest lands? How is it sold? To whom? Explore the policies governing the sale and cutting of timber from state forest lands. How much income does the state derive per year from the sale of lumber?

22. View and discuss TV films, "Forest Pests" and "Controlling Forest Pests", available from the Department of Natural Resources.

SUGGESTED ACTIVITIES:

1. Make a survey of the local community, township, or other convenient area to locate the different types of "forest communities". Some forest areas that may be studied are tamarack, spruce or cedar, bogs and swamps, river flood plains, northern hardwood forests, southern woodlots, etc. List the predominant species of trees that grow in these areas; and note any differences in the kinds and abundance of herbaceous plants, shrubs, and under-story trees in each type of woodlot.

2. Make collections and learn to identify the different kinds of trees that are common in Michigan.

3. If you live in a forested region or an area that is too hilly or sandy for profitable agriculture, make a survey of your community to determine whether any of the land should be reforested or not. If a land use map has been made of the county by a committee of local citizens in cooperation with the Extension Service of Michigan State University, use it in connection with this project. (If such a map exists, the County Extension Agent should have a copy in his office.)

4. Investigate various methods of tree planting. Compare the costs of hand planting and machine planting. Compare the number of trees that can be planted in an eight-hour day by ten men using dibbles, and the number that can be planted per day with a planting machine requiring a two-man crew. Calculate the cost per thousand trees planted by the two methods, not forgetting to include cost of operating trucks and tractors. Under what conditions are tree planters impractical?

5. If practicable, visit a tree planting operation to observe planting machines at work. Consult a Forester to find out where and when such planting is to be done.

6. Visit a cedar swamp in which deer "yard" during the winter. If possible visit it in winter and early spring. Look for evidence of a "browse line" below which the deer may have eaten everything they can reach in winter. This is evidence of too many deer in the area. Arrange to have the District Game Manager or District Forester accompany you on this trip. Contact the nearest Department of Natural Resources office for consultant help on this trip.
assistance.

7. Visit a woodlot or forest in spring and look for evidence that young trees (2-4' high) have been damaged by deer. If tops of seedling trees are bitten off a number of crooked, offset branches develop below the injury, which often give the young trees a deformed witches' broom appearance.

8. Make a collection of insects that damage forest trees; identify and label them. Twigs, leaves, or other parts of trees showing the kind of damage done by the insect add interest to the collection.

9. In older stands of pine (15-20' high), note the difference between trees growing close together and those growing in open stands (far apart); or better yet, isolated trees. Explain why trees growing close together lose their lower branches and grow tall and straight. The same effect can often be seen in a grove or forest of deciduous trees (trees that shed leaves).

10. Why is it good forestry practice to plant trees close together and then thin them out by selective cutting when they are large enough for pulpwood?

11. Visit a farm woodlot which has not been pastured. Notice such important items as the kind of trees, the relative abundance of the different kinds of their spacing, the abundance or scarcity and kinds of young trees which should eventually replace the mature trees after they are cut or removed by natural causes, the abundance and variety of herbaceous plants and shrubs in the woods and at the edge of the woods. Look for "den" trees, "wolf" trees, diseased trees, or injured trees. Look for trees with fire scars near their base.

12. Visit a pastured woodlot. Compare with the unpastured woodlot. Note differences in the amount of undergrowth. What will eventually happen to the woodlot which is permanently pastured? If possible, arrange to have a local resource person, such as a forester, game biologist or County Agent to accompany the class on these field trips to woodlots and other forest areas. He can point out many things about forest management which might otherwise be overlooked. View TV film "Role of the Farm Woodlot" available from Department of Natural Resources.

13. While visiting woodlots and other forest areas, observe the amount of forest litter and humus on the forest floor. Discuss how trees and the litter of dead leaves and branches on the forest floor absorb rain water, slow down runoff, prevent erosion and help to prevent floods. Explain how forest litter builds up the soil.

14. Look up the history of forests and logging operations in your community or county. Are there any "ghost" towns in your county? If so, study their history and discuss why some towns survived and others did not.

15. Visit a logging operation or a local sawmill to see how trees are being cut and sawed into lumber.

16. Find out the value of the uncut trees (stumpage value) in a woodlot or 40-acre tract of forest.

17. Compare the monetary value of timber at different stages of harvesting; (a) stumpage value, (b) value per cord when cut and piled for hauling to a mill, (c) value of sawed lumber at the mill, (d) value of seasoned lumber at the lumber yard. Explain why a cost increase occurs at each step in the process. Point out what this means to the economy of the local community, to the county, and to the state. The ultimate value of any natural resource increases in proportion to the amount of work (size of payrolls) and the cost of processing the finished product (machinery, equipment, etc.) including transportation charges, etc.

18. Visit a lumber yard. Obtain figures on the cost of various kinds of lumber. Find out where the various kinds of lumber in the yard came from; i.e., geographical origin. List the uses of various kinds of lumber. Compare costs of different grades of lumber. Learn to recognize different grades of lumber.

19. List as many different products as you can which are derived from trees. Refer to chart D-5, "What We Get From Trees", issued by U.S. Forest Service. Students may prepare oral or written reports on how these products are made.

20. Determine which species of trees are used in the manufacture of the following products: (a) pulpwood and paper, (b) charcoal, (c) chemicals from wood (based on a few specific chemicals, (d) plastics, (e) veneer, (f) plywood, (g) posts, telephone poles, etc., (h) mine timbers, (i) others. View TV film "Forests To Furniture", available from the Department of Natural Resources.

21. Locate areas in the state where individuals make all or a major part of their living from forest activities.

22. Survey the types of wood used in homes. Estimate the amount of each type needed to build a 5-room house. What proportion of the cost of building such a house is for lumber? for heating, plumbing, lighting, etc.?

23. Plan a field trip to study a local watershed. What is a watershed? Investigate drainage, surface runoff from rain and snow, erosion and water table. What forest management measures might be employed to improve the watershed? Would such improvements benefit the soil, improve farm incomes, affect local taxes and prosperity, improve fishing, hunting, and other kinds of recreation, reduce property damage and floods, raise water table, etc.? Explain how or why in each instance.

24. Investigate extent to which recreational uses of the forest benefit your community. Consult local businessmen, chamber of commerce, or tourist bureau.

25. Consider trees as a crop. How can a regular harvest of trees from a woodlot or forest be insured? What is meant by improvement cutting, selective cutting, cruising timber, scaling timber, slash, good growing stock?

26. Study the use of trees for windbreaks. Under what conditions of soil, topography, climate and land use practices can windbreaks be used effectively? Look up the history and success of the shelter-belt program initiated in the plains states during the drouth years of the thirties.

27. If you have a school forest, use it as an outdoor laboratory. Too often teachers and students conclude that they have exhausted the possibilities of a school forest when they have planted as many trees as circumstances

permit. Do not forget that many phases of nature study, forest management and game management can be studied after the planting has been done.

For example, studies can be made involving the survival and growth rates of trees; studies of thinning, pruning and other stand improvement practices can be made; diseases and damage by insects can be studied; forest fire prevention measures can be carried out; the effect of the trees (and accumulation of litter) on soil erosion and water-holding capacity of the topsoil can be studied; the effect of trees on temperature, humidity and wind velocity can be determined; and the abundance, distribution and variety of ground cover (herbaceous plants and shrubs) as well as seasonal abundance and distribution of wildlife, including both game and non-game species, offer almost endless possibilities for using the school forest to advantage.

28. Visit a "sugar bush" in early spring if practicable. Find out how trees are tapped and how maple syrup is made. In which counties is maple syrup an important product? Does repeated tapping over a period of years injure the trees? What kind of equipment is needed to make maple syrup? How much does it cost? Are there any state laws regulating the quality and purity of maple syrup? If so, what are they and who enforces them?

Fish and Wildlife

ATTITUDES AND UNDERSTANDINGS TO DEVELOP:

The following statements are substantially the same as those listed for the intermediate grades. Fundamental concepts change only as research provides a better understanding of Nature's laws; they are independent of grade levels.

1. Animals of all kinds, including fishes and other aquatic life, are directly or indirectly products of the land.

2. Fish and wildlife are affected by many environmental factors such as climate, soil, water, vegetation, other wild or domestic animals, and man.

3. No individual or species can escape the pressure exerted by the physical and biological factors which are operative in its habitat.

4. Each species which lives in a given unit of habitat, whether it be a soil organism, insect, amphibian, reptile, fish, bird, or mammal, occupies a unique ecological niche in the wildlife community.

5. Competition for food, cover, and living space between species and individuals of the same species becomes intense in any animal community, and a complicated system of checks and balances (often called the "balance of nature") serves to keep each species from getting out of control and becoming too abundant.

6. Animal communities differ to the extent that their habitats differ, and these differences may be very obvious or almost imperceptible.

7. The animals of any ecological community are adapted morphologically and physiologically to the physical, biological, and climatic conditions of their habitat.

8. Most animals (including fish) are extremely sensitive to any change in their environment; and, as a result, wildlife populations fluctuate, sometimes violently, in response to seasonal and long-range variations in climate, and to changes in their habitat due to the effects of fire, wind, water, and the activities of man.

9. Man may alter the composition and abundance of a wildlife population by changing, destroying, or managing its habitat.

10. Man may introduce new species into an area with results that are harmful, or beneficial, or have little obvious effect.

11. Man's use of the land (including lakes and streams), his clearing and burning, draining and flooding, grazing and crop production, urbanization and industrialization have wrought great changes in the composition and abundance of wildlife populations. As a result, some species have become extinct, some scarce, and others more abundant.

12. Man can manage wildlife habitats for the benefit of desired species; sometimes at little cost in time, effort, and money; but in other cases, at considerable cost.

13. Predatory species generally do more good than harm because they prevent their prey from becoming over-abundant and thus tend to maintain the so-called "balance in nature".

14. Every unit of land and water (habitat) has a limited capacity in providing food, cover, and living space (carrying capacity) for fish and wildlife. This carrying capacity can sometimes be increased if we improve the habitat and thus, insofar as practicable, remove the limiting factors.

15. Hunting and fishing are legitimate recreational pursuits, if properly regulated, because most species of game and fish produce more young under normal breeding conditions than their habitats can support.

16. Many herbivorous species which are subject to predation such as mice, rabbits, gophers, and squirrels have a high breeding potential (large litters and two or more litters per year); whereas carnivorous species generally have a low breeding potential (small litters and one litter per year). This insures the survival of prey species despite heavy predation by their natural enemies and man.

17. Hunting and fishing regulations (open and closed seasons, bag limits, creel limits, and methods of taking game and fish) are designed to insure an orderly harvest and to remove only the annual surpluses of game and fish without depleting the breeding stocks.

TOPICS FOR DISCUSSION:

1. List the species of big game, small game mammals, upland game birds, and waterfowl of the state; and have students study and give oral reports on selected species with regard to size, appearance, preferred habitats, breeding potential, food habits, home range (cruising radius), enemies, longevity, and economic importance.

2. The same type of study and reporting should be carried out with respect to selected species of fish that are common in Michigan waters.

3. Environmental resistance is defined as the total of all limiting factors which affect a species. Have students list as many factors as they can which limit populations of (1) deer, (2) bear, (3) beaver, (4) muskrat, (5) raccoon, (6) cottontail rabbit, (7) fox squirrel, (8) fox, (9) ringneck pheasant, (11) quail, (12) ruffed grouse, and (13) prairie chicken.

4. Discuss the circumstances under which winter feeding of pheasants or other game birds is justifiable.

5. Study the provisions of the Wildlife Sanctuary Law. How does a farmer or other land owner go about getting his property dedicated as a wildlife sanctuary? What rights does the owner give up when he has his land so dedicated? Are wildlife sanctuaries effective in building high populations of pheasants and other small game species? Why?

6. Review the history of big game refuges in northern Michigan. Why were they eventually opened to hunting?

Refer to reprinted article, "Game Refuges and Public Hunting Grounds in Michigan". Single copies available from Game Section, Department of Natural Resources, Lansing.

7. Assign reading from "Life and Times of Michigan Pheasants", by R.A. MacMullan. (Copies should be available in your school library). Discuss the (1) history of pheasant introductions in the state, (2) food and cover requirements, (3) reproductive potential, (4) limiting factors, (5) effect of farming practices on pheasants, (6) breeding habits and nesting success, (7) trends in population since 1930, and (8) present range of pheasants in the state.

8. List and discuss the life histories, habits, and habitats of the predatory mammals of the state. Reference: "Michigan Wildlife Sketches" by Bradt and Schafer, available from Hillsdale Educational Publishers, Inc., P.O. Box 245, Hillsdale, Michigan 49242.

9. Debate the pros and cons of the bounty system. On which predatory species are bounties paid in Michigan?

10. List the species of birds and mammals that are not protected by law in Michigan. Refer to the "Rules for hunting small game in Michigan".

11. Why are hawks and owls now protected in Michigan? What exceptions, if any, are provided in the law?

12. Review the history of the Migratory Bird Treaty Act. Why and when was it enacted by Congress? What general groups or categories of birds are protected by this Act?

13. What is the trend of the bald eagle population in Michigan? Throughout the U.S.? What reasons are believed to be responsible for this trend? Look up recent articles in MNR magazine and in other magazines such as Audubon Magazine, National Wildlife, National Geographic, Natural History Magazine, Reader's Digest, etc. (The school librarian should be able to assist you.)

14. Trace the history of the Michigan deer herd from pioneer times to the present. Draw a graph showing the years of abundance and the years of scarcity. What factors led to their decline and the closing of many counties to all-deer hunting in the first two decades of the present century? What factors led to their phenominal increase in the 1930's and 1940's? Also, trace the history of deer hunting regulations, e.g., bag limits, buck law, etc. Refer to "Michigan Whitetails" by Jenkins and Bartlett, available in your school library."

15. How does summer deer range differ from winter deer range? How does the area of winter deer range compare with the area of summer range? Why is it impracticable to move deer from browsed-out starvation areas to places where food is more plentiful? What other states besides Michigan have legalized shooting of anterless deer.

16. Why is it impracticable to attempt to feed deer from starvation areas? List the problems involved other than cost. Will deer thrive on a diet of alfalfa hay? What kinds of winter foods would have to be supplied? Is cutting cedar for posts in browsed-out swamps (deer yards) in winter an effective means of feeding deer? What is the limiting factor (or factors) in this kind of operation? Review the experimental work that has been done at the Department's wildlife experiment stations on the varieties and quantities of browse (food) necessary to sustain a deer in good condition during the winter months.

17. How large is the southern Michigan deer herd? Should it be reduced by legalized doe shooting in certain counties to alleviate damage to farm crops, orchards, commercial nurseries, and alleviate the traffic hazard? Information available in Department's bulletins and in magazines.

18. View the film "The Michigan Deer Story", available from the Department of Natural Resources.

19. Discuss bird migration, including some of the theories regarding how they find their way to distant wintering areas and return to the same nesting area in spring. Refer to encyclopedias and bulletin, "Migration of Birds"

available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. View the film "Birds and Migration" available from the Dept. of Natural Resources.

20. Discuss wildlife cycles of abundance and scarcity. List the species of game birds and mammals of Michigan that are known to be "cyclic".

21. Discuss the life histories of the following fishes: bluegill, black bass, northern pike, walleyed pike, rainbow trout, brook trout, brown trout.

22. Discuss the factors that may limit fish populations: (a) basic fertility of the water, (b) land use in the watershed, (c) water temperature and light penetration, (d) silt in the water, (e) pollution by sewage, harmful chemicals and other waste products of industry and by chemical herbicides and insecticides, (f) character of the bottom of a lake or stream with respect to spawning sites, food organisms, and shelter, (g) aquatic vegetation, and (h) predators.

23. Compare the fish carrying capacity of a lake with that of a pasture for livestock.

24. Under what circumstances is restocking a lake with hatchery fish advisable? Not advisable?

25. Show motion picture films, available from the Department of Natural Resources: (1) "Warm Water Fish Management, Part 1", (TV film no. 235), (2) "Warm Water Fish Management, Part II", (TV film no. 236), and (3) "Warm Water Firm Management, Part III", (TV film No. 237).

26. Discuss the invasion of the Great Lakes by the sea lamprey and study its life history and habits. Show motion picture "Great Lakes Invader" and TV film No. 204, "Combatting the Sea Lamprey", available from the Department of Natural Resources.

27. Discuss the Great Lakes fisheries rehabilitation program, including the introduction of salmon and the control of the alewife. Refer to publications in the Great Lake fisheries program and view the film "Coho," all available from the Department of Natural Resources.

28. What is meant by the spring and fall "turnover" that characterizes moderately deep inland lakes? How does it relate to seasonal changes in water temperature? At what temperature is water heaviest? On the basis of temperature, there are three layers of water in such lakes during the summer months. Show by diagram the temperature variations in each layer. How does this affect the behavior of fishes? Refer to books on limnology and animal ecology.

29. Discuss the reasons for removing the closed fishing seasons, creel and size limits on most species of pan fish. Refer to Fish Law Digest for list of species that can be fished the year around.

30. Fish and game in this country are owned by the state (that is, by the public), but this does not give the licensed hunter or fisherman the right to hunt or fish on private land without permission of the land owner. What are some of the solutions to this dilemma?

SUGGESTED ACTIVITIES:

1. Since all species of wildlife have specific living requirements and are subject to all of the physical and biological forces in their total environment, have students prepare charts listing the summer and winter habitat requirements of the following birds and mammals: deer, bear, fox, cottontail rabbit, fox squirrel, meadow mouse, weasel, mink, skunk, woodchuck, muskrat, beaver, bobwhite, mallard duck, woodcock, ruffed grouse, pheasant, prairie chicken, sharptail grouse, wild turkey, bluebird, song sparrow, catbird, blue heron, marsh hawk, great horned owl, and common crow. In the foregoing consider needs for dens, nests, food in summer and winter, and cover for rest and play, shelter from heat, cold, wind, rain, snow, and escape from enemies.

2. Using Michigan Wildlife Sketches for reference, have students construct a chart comparing the breeding potential of the mammals in the foregoing list. The following information should be recorded for each species: young per litter, litters per year, earliest breeding age, length of life, prey or predatory. Note the relationship between life span and number of young per litter and litters per year. Do prey species produce more young per year than predatory species? Why? What would happen to the habitat if all or most of young produced by rapid breeders were to survive and breed? Define "breeding potential".

3. Take a field trip to a farm, a forest, or a marsh to study the food and cover conditions that are favorable or unfavorable for the game birds and mammals that would be expected to inhabit the area visited. Are there areas that lack sufficient food and cover to meet the needs of game birds and mammals in any season of the year? Could any of the deficient areas be improved by providing additional food and cover, or by changing the pattern of land use at reasonable cost? Draw up a management plan for the area visited to show how and where improvements in the wildlife habitat could be made. In this connection, map the area to show existing conditions (lakes, streams, swales, hills, kind and distribution of vegetation, etc.) and superimpose recommended improvements for wildlife.

4. Students may choose to collect plants for identification. Plant identification should not be an end in itself but a project such as this should be used as a vehicle leading to further study of plant ecology. It is important to know the common names of plants, but too often identification becomes the sole objective. Knowing the condition under which plants live and their relationship to other plants and to animals is a better objective if the student is to gain an understanding of wildlife. Concentration of attention on species of plants that are used by wild animals would serve a double purpose of learning about the plants as well as the animals that use them. Students should note also that the plants growing in one kind of habitat differ from those growing in other habitats. Compare the vegetation found in upland and lowland woods, swamps, marshes, open wasteland, cut-over or burned-over areas, etc.

5. Collecting seeds, fruits, and nuts (including different kinds of acorns) that are used by game birds and mammals is a fascinating project. For identification of fruits and nuts refer to "Fruit Key and Twig Key to Trees and Shrubs" by William M. Harlow and, as an aid in identifying seeds, labelled collections can be obtained from biological supply houses. This project should involve, among other things, the relation of wildlife to seed dispersal and the value of different kinds of seeds, fruits, and nuts in the diet of wildlife species. Refer to "American Wildlife and Plants: A Guide to Wildlife Food Habits," by Martin, Zinn and Nelson as a source of

6. Many species of mammals are nocturnal or so secretive and shy that they are rarely seen. Tracks then become the most tangible evidence of their presence. Tracks, however, are not always reliable in estimating the abundance of a species; one rabbit, or squirrel, or deer, or pheasant, can make a lot of tracks during the course of a single night or day. This might lead a student to think that some mammals and birds are much more numerous than they really are. Look for tracks of birds and mammals in the mud or moist sand along a stream bank or lake shore, or look for them in fresh snow. Roadsides and sandy trails through woods and fields are good places to look for tracks. If old tracks of animals or vehicles are numerous, have the students obliterate all the old tracks along a short stretch of trail, farm lane, or sandy area. This can be done by sweeping or dragging a plank over the sand. If this is done late in the afternoon, the tracks of all the animals which cross the trail or follow it can be seen and counted in the morning.

   Trailing such animals as the mink, skunk, fox, and even the deer or bear is worthwhile because the careful observer will learn much about the animal's habits: its food and cover preferences, peculiarities of behavior, extent of area in whcih it lives, etc. Distinguish between prints of front and hind feet in instances where they differ in size and shape. Note spacing and relative position of front and hind footprints. This is frequently more significant than toe and claw marks, especially in snow which sometimes does not register the foot pad characteristics. The position of the individual footprint frequently varies with the gait of the animal. The tracks made when running differ considerably from those made by the same animal when walking or hopping.

   A. Make plaster of Paris casts of animal tracks in mud or sand.

B. Take photographs of animal tracks for scrapbooks and posters.

C. Have students study and identify all tracks seen on field trips and encourage them to make this a project for after-school hours and vacation days. Have them keep records (brief descriptions and sketches) of tracks and trails observed. A contest may create interest and incentive. Books on this subject are included in the reference list.

7. In connection with the discussion of hawks and owls (No. 11 in the foregoing section), have students make a survey and report on the hawks and owls seen in the local community. Study the identifying characteristics of different species of hawks and owls. Obtain copies of "What Hawks Eat", a leaflet available from the National Audubon Society; and "Food Habits of Common Hawks", Circular No. 370, U.S. Department of Agriculture, for student reference.

   If possible, locate a tree or trees where owls habitually roost or nest. Evergreens seem to be preferred roosting sites. Look for and collect pellets on the ground beneath the roost. They consist of matted fur and undigested bones that are regurgitated (coughed up). They are dry and not objectionable to handle. Dissect them in the laboratory and try to identify the animals eaten from the hair, feathers, and bones contained in the pellets. Compare the bones with the pictures of skulls, jaws, and teeth in Burt's "Mammals of the Great Lakes Region", (University of Michigan Press).

8. List the animals that are regarded as predators in your county. What is done to control any of these predators? We must measure all of the ecological relationships of an animal species before we condemn it. For example, even though the fox kills game, it has other values to offset the damage it does; for instance, it has been definitely shown that destructive field mice are the major item in a fox's diet wherever and whenever such mice are plentiful enough to do damage to farm crops, orchards, and nurseries. Have students read Chapters XIV and XV if "Our Wildlife Legacy" by D.L. Allen (Funk and Wagnalls, New York). Debate the pros and cons of the bounty system of predator control after reading the reference above.

9. Study the economic importance of fur bearers in the development of our state. What were the first white residents of Michigan other than missionaries? What were they seeking? What animals attracted them to Michigan? Where were the fur markets of those days? Did the trappers have any effect on animal species that survived?

   A. Make a survey to determine the present status of fur bearer populations in your community. Interview trappers and fur buyers, and have students make written or oral reports on findings.

   B. Considering the habitat requirements (food and cover) of various fur bearers, locate the best habitats in your community or township for different fur bearers and plot on a map. Indicate on map the location of known dens, muskrat marshes, beaver dams, etc.

   C. Visit a muskrat marsh or beaver pond at various seasons of the year and evaluate food and cover conditions. Estimate populations of muskrats or beaver. Observe habits of these animals. What are the most important factors for a good muskrat marsh?

10. Have students consult local trappers and fur buyers on how to grade furs. What are prime and unprime pelts? Learn to distinguish them. Find out how to skin and stretch pelts of different animals. Experienced trappers and fur buyers can advise students on this. Consult local conservation officers or the trapper instructor at the regional or local Dept. of Natural Resource office.

11. Discuss beaver damage to timber, pastures, and farm crops. How are "beaver complaints" handled by the Department of Natural Resources? Have someone in class describe a beaver live-trap. Do beaver injure trout streams? Debate this question after having class look up reference material on the subject.

12. October is an ideal month for a deer census. This is done by choosing a typical area, possible a mile or more square, depending on the number of people taking part. On three sides of the square, station people every few yards for counting. Each one counts the number of deer passing on his right between him and the next counter. On the fourth side, a line of people make a drive slowly through the area, remaining in a straight line and crashing, shouting and otherwise scaring the deer towards the counters. (Ask for the free publication of the Department of Natural Resources entitled, "Instructions for Conducting Deer Census Drives".) Deer drives may not be practical unless your school is located in or near a wild-land area.

    Visit a deer yard. Note the browse line, if it is present. Find out from a game specialist whether all swamps in the area are used to the same extent. Discuss with the class whether the herd is too large in your area. If the deer herd is detrimental to truck crops, orchards, nurseries, or other farm crops in your community, find out what damage the deer have done and what controls are in operation. The county agricultural agent will be able to give useful information on this subject.

    Have students interview old deer hunters and write up their experiences. Evaluate these stories.

    On a map showing state boundaries, indicate all of the states which permit anterless deer shooting, and those which permit shooting of bucks only.

    Obtain booklets and pamphlets on deer from the Department of Natural Resources for reference use.

13. Obtain outline maps of Michigan on which county boundaries are indicated. (Large quantities of such maps 8½"x11", can be run off on a duplicator.) Use separate maps to indicate in shading or color the geographic distribution (range) of each important species of game bird and mammal (including fur bearers) in the state. Have students write or discuss the reasons why some species are restricted to certain counties or areas of the state, and others are of state-wide distribution. Also discuss areas of greatest abundance and scarcity of different species. A short summary of the animal's habitat requirements, limiting factors, and life history may be appended to each map. This activity involved geography, history, and the impact of civilization on wildlife. It should be of more than average interest to students.

14. Have students study the laws and regulations governing the taking of fish and game. Do not expect students to agree on the wisdom of all game and fish laws. Point out that they are enacted by the Legislature and, except in case of beaver and otter, the Natural Resources Commission has only limited authority over seasons, limits, and methods of taking fish and game. However, if in the opinion of the Natural Resources Commission any species is in danger of extermination, it can shorten seasons and decrease bag and creel limits, but it cannot lengthen or increase them except for scientific experiments in limited areas.

15. Have students make a list of game birds and mammals that are completely protected by law (no open hunting seasons). Make another list of birds and mammals that are not protected by law.

16. Find out whether any group of farmers in your community have organized a "Williamston Plan Cooperative Hunting Club" to control hunting on their land. This has been most important in the southern portions of the state where hunting pressure has been felt on privately owned lands. Under this plan a hunter is required to stop at the farmhouse and secure a permit to hunt on the farmer's land, his car is left at the farmhouse where it may be reclaimed when the permit is returned to the farmer. In this way, only a definite number of hunters may use a piece of property at the same time. One of the most difficult problems in game management is controlling the harvest. Hunting seasons and bag limits are actually a very rough way of doing this. Regulations of numbers of hunters on a given area, plus hunting seasons and bag limits would regulate the harvest much more satisfactorily. Interview some of these farmers to find out how effective the plan is, and whether or not they are satisfied with the results.

17. Arrange for a field trip to a state game area or other state or federally owned area in your locality that is managed for wildlife and public hunting. The local Conservation Officer or Game Biologist can advise you

concerning the location of such publically owned lands. Look for evidence of game species and habitat improvements, such as impoundments for waterfowl and fur bearers, food and cover plantings, brush piles for rabbits and other animals, small clearings in dense timber stands to create a more varied habitat for upland birds and mammals. Open fields in northern forests have been called idle lands by some people. Is this an appropriate name for them?

18. Dramatize in an assembly program the wrong and right methods of carrying guns, climbing fences with them, care of guns, etc. Emphasize constantly good sportsmanship and safety in hunting. Every school boy should have this training. Your local Conservation Officer may be able to help you in this activity.

19. What exotic (not native to this country) game birds have been introduced into Michigan? List those which have succeeded and still survive. List those which have failed. What factors contribute to success or failure in each instance?

20. Professional wildlife conservationists agree that the way to provide an abundance of game of any species is to make sure that the habitat is favorable for desired species. This means that food and cover conditions must be as nearly ideal for the species as possible depending upon the major use of the land concerned. For example, the farmer's chief concern is raising crops and livestock, and wildlife management has to be secondary to food production. However, almost any Michigan farm has some land unsuited to agriculture: fence rows, swales, woodlots, etc., which can be improved for pheasants, squirrels and rabbits.

    Contact a local farmer and arrange for a field trip to study wildlife conditions on his farm. He may be willing to talk to the class about what provisions, if any, he makes to improve wildlife habitat; and about the problems he has with the hunting public.

21. More than 660 school districts in Michigan have acquired land from the state for school forests. Some of them have been developed and used as outdoor laboratories, others have not. They could be ideal for developing good wildlife habitats as a school project. If your school has such an area, have students study and map it. All topographic features such as hills, swales, lakes and streams should be drawn to scale. Soil types should be indicated. A second map showing existing cover types (open, grasslands, brushy areas, woodlands, swamps and marshes) should be made.

    Let the class prepare a five-year management plan for the area. This should involve tree and shrub planting for wildlife as well as for timber. Food patches involving corn, buckwheat, soy beans, sweet clover, lespedeza, alfalfa, etc., may be important if there is evidence of a scarcity of winter food. Note that legumes require lime in the soil. If the soil is acid it will have to be treated with lime before sweet clover, alfalfa, or lespedeza are planted. Fertilizer may also be needed if the soil is very poor. Soil conservation practices should be considered in the plan. There may be gullies, eroding stream banks, and sand blows to contend with. Then estimate the cost of developing the area.

22. Find out whether the Department of Natural Resources has done any waterfowl habitat restoration work in your county. A number of dams have been constructed on state game lands in southern Michigan and state forest lands in the northern part of the state to flood marsh lands for waterfowl and fur bearers. Visit one of these projects with your class if it is within reasonable driving distance. Possibly you can arrange for the Local Game Biologist to accompany you and explain the details of marsh management. Contact him at the nearest district headquarters of the Department or write to the Regional Game Supervisor at the nearest regional office.

23. Obtain some fishes of different species (perch, bluegill, bass, pike, walleye, trout, carp, sucker, bullhead) and learn to identify them by comparing their shape, position and structure of fins, mouth, gill covers, scales, etc. Compare the number of spines in the anterior dorsal fin. Are the anterior and posterior dorsal fins separate or joined together? Note the difference in position of the pelvic fins of the bass, bluegill or perch and the trout. How does the posterior dorsal fin of the trout differ from that of other fishes? Note that the anal fins of the

perch, bluegill and most other members of the sunfish family have spines as well as soft rays in the anal fin, but only soft rays occur in the anal fin of the pike and trout. The foregoing are a few of the diagnostic features by which different families of fish are distinguished and classified. There are several others to be considered in learning to recognize different species of some families of fish.

24. Remove some scales from a fish, clean and mount them on a slide for microscopic examination. Look for a series of concentric rings in the scales. Because fish grow little during winter months, the concentric rings of each summer's growing period are separated by a thicker ring called an annulus or winter mark. The age of the fish can be determined by counting the winter marks. However, it takes careful study and some expert experience to become proficient in aging fish by this method.

25. Have students prepare a chart showing the season of the year during which brown, brook, and rainbow trout spawn. Indicate also the species which migrate up rivers and brooks to spawn, and which are not migratory.

26. Visit a fish hatchery if practicable to observe how fish eggs are hatched and how the fry, fingerlings, and larger fish are fed and cared for until they are large enough for release in streams or lakes.

27. Likewise, arrange a field trip to a commercial fishery and if possible have the owner demonstrate the types of nets employed in taking fish and how they are used; also how fish are prepared for shipment to markets. Find out what problems he is encountering in making a living by commercial fishing. Consider his investment, depreciation of equipment, overhead costs, etc.

28. If it is convenient to visit a trout stream, have the class make a survey of a section of it (possible a few hundred yards) to locate deep pools where trout hide and rest, and gravelly or stony shallows suitable for spawning. Are the shallows choked with sand? Are they suitable for spawining? Examine the undersides of rocks and pebbles for aquatic insect larvae on which trout feed. Collect specimens of such organisms in jars of water for study and identification in the laboratory.

29. Collect water samples from various depths in a pond or lake and examine them with a microscope for plankton organisms. Various species of algae and such minute animals as cyclops, ostracods, copepods, rotifers, and protozoa may be seen. Compare the abundance of such organisms at various depths. What factors determine their abundance? Such organisms are the primary links in the food chain of fishes.

30. Collect aquatic insects, crayfish, snails, minnows, and tadpoles for an aquarium.

31. Construct a chart to illustrate the food chain of typical warm water fishes.

32. Look for spawning "nests" of bass and bluegills in shallow water near the shore of an inland lake during May and June. Their nests which consist of shallow depressions in pebbly lake bottoms are made by fanning away the silt and sand with their tails. Because the males defend the nests until the eggs have hatched, bass fishing is not legalized until the spawning season is ended.

33. Survey rivers and lakes in your community for sources of pollution that are detrimental to fish life and recreational activities. Report any evidence of pollution or fishkills to your local Dept. of Natural Resources headquarters.

REFERENCES

The following books and bulletins are recommended (A) for teachers, and (B) for pupils. However, some of the references for teachers may not be too difficult for the better student readers.

Teachers will please note that the majority of the books and bulletins listed below must be ordered directly from the publishers. The Department of Natural Resources can supply only the bulletins and circulars which it publishes and, even in this case, it cannot fill bulk orders for each member of a class. The best it can do is provide a few copies for library use, or in some instances, a single copy which may be duplicated.

Prices are generally omitted because they are subject to change without notice. In addition, you may find that some items are out of print by the time your order is received. This is a weakness of all bibliographies that cannot be avoided.

Geology and Mineral Resources

FOR TEACHERS OR STUDENTS

1. **Historical Geology,** by R.C. Hussey; McGraw-Hill Book Company.

2. **Field Book of Common Rocks and Minerals,** by F.B. Loomis; G.P. Putnam's Sons.

3. **Minerals of Might,** by Wm. O. Hotchkiss; Jacques Cottell Press.

4. **Minerals and World Affairs,** by T.S. Lovering; Prentice-Hall.

5. **Handbook of Paleontology for Beginners, Part I, The Fossils,** by Winifred Goldring; New York State Museum Handbook, No. 9, Albany, New York.

6. **School Program Materials,** a teacher's packet which includes bulletins, charts, and maps dealing with oil and petroleum products. Available from the Associated Petroleum Industries of Michigan, 118½ West Ottawa Street, Lansing, Michigan.

7. Bulletins available from Michigan Department of Natural Resources, Lansing 48926. Free unless price is indicated.

   Collecting Minerals in Michigan
   Glacial Lakes Surrounding Michigan
   Rocks and Minerals of Michigan, 50 cents plus tax
   Michigan Mineral Industries Reports
   Our Mineral Resources
   Michigan's Rock Riches, 50 cents

8. Basic Science Education Series; Row, Peterson & Company.

   Stories Read From Rocks
   The Earth's Changing Surface
   Our Ocean of Air
   The Earth, A Great Storehouse
   Life Through The Ages

9. Basic Social Education Series; Row, Peterson & Company.

   America's Minerals
   Buried Sunlight, The Story of Coal
   America's Oil
   Our Inland Seas, The Great Lakes

10. **Geology,** by C.L. Cooper et al; Boy Scouts of America, New York——25 cents.

11. **The Rock Book,** by C.L. Fenton; Doubleday, Doran & Company.

12. **Rocks and Their Stories,** by C.L. and M.A. Fenton; Doubleday, Doran & Co.

13. **Our Amazing Earth,** by C.L. Fenton; Doubleday, Doran & Company.

14. **Life Long Ago,** by C.L. Fenton; Reynal & Hitchcock Company.

15. **So That's Geology,** by R.R. Baker; Reilley & Lee Company.

16. **Exploring Earth and Space,** by Margaret Hyde; McGraw-Hill Book Company.

17. **Before and After Dinosaurs,** by Lois & Louis Darling; Wm. Morrow Company.

18. **The Story of Earth Science,** by H.G. Richards; J.B. Lippincott Company.

19. **Quick-Key Guide to Rocks and Minerals,** by Carl J. Bowser, R.M. Gates & D. Archbald; Doubleday & Co., Inc.

Water Resources

FOR TEACHERS OR STUDENTS

1. **A Primer on Water,** by Luna B. Leopold and W.B. Langbein; U.S. Geological Survey publication. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

2. **Conserving American Resources** (chapt. 6), by Ruben L. Parson; Prentice-Hall.

3. **Conserving Natural Resources** (chapt. 3), by Shirley W. Allen; McGraw-Hill.

4. **Water Or Your Life,** by Arthur H. Carhart; J.B. Lippincott Company.

5. **Land, Water, and People,** by Bernard Frank & Anthony Netboy; Alfred A. Knopf Publishers.

6. **Water,** The Yearbook of Agriculture, 1955, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. If out of print, it should be available in libraries.

7. **The Wonders of Water,** by Marian E. Baer; Ferrar & Rinehart.

8. **Water, Water Everywhere,** by Mary Welsh; Abingdon-Cokesbury Press.

9. **Exploring the River,** by John & Jane Perry; Whittlesey House.

10. **Water is Wonderful,** by Mary I. Curtis; Lyons & Carhahan, Inc.

11. **Water For America,** by Graham and Van Dersal; Oxford University Press.

12. **Water —— Our Most Valuable Natural Resource,** by Ivah Green; Coward-McCann.

13. Michigan Department of Natural Resource Bulletins, Lansing.

    Is It True What They Say About Water, by Norman Billings

    Water For Michigan, reprint from MICHIGAN NATURAL RESOURCES MAGAZINE, March-April, 1960.

14. Water Resources Division, Michigan Dept. of Natural Resources, Mason Bldg., Lansing, Michigan 48926

15. U.S. Department of Health, Education and Welfare, Washington, D.C. Bulletins available from this agency on pollution control, sewage treatment, etc.

16. **The Conservation of Ground Water,** by Harold E. Thomas; McGraw-Hill Co.

17. **Water,** by Thomas King; The Macmillan Company.

18. **Downstream: A Natural History of the River,** by John Bardach; Harper & Row, Publishers. $5.95.

19. Contact the Federal Water Pollution Control Administration, U.S. Naval Station, Grosse Ile, Mich; 48138

Soils and Land Use

FOR TEACHERS OR STUDENTS

1. **Our Soils and Their Management,** by Roy L. Donahue; Interstate Printers & Publishers.

2. **Our Plundered Planet,** by Fairfield Osborn; Little, Brown & Company.

3. **Deserts On The March,** by Paul B. Sears; University of Oklahoma Press.

4. **Elements of Soil Conservation,** by H.A. Bennett; McGraw-Hill Company.

5. **The Soils That Support Us,** by Chas. E. Kellogg; The Macmillan Company.

6. U.S. Soil Conservation Service, Washington, D.C. The following bulletins:

    No. P.A. 201, **Outline For Teaching Conservation In High Schools**
    No. P.A. 341, **Teaching Soil and Water Conservation,** A Classroom and Field Guide.

7. **This Is Our Soil,** by Walker & Foster; Interstate Printers & Publishers.

8. **The Land Renewed,** by Van Dersal & Graham; Oxford University Press.

9. **Conserving Soil Resources,** by Paul W. Chapman et al; Turner E. Smith Co., 441 W. Peachtree St., N.E., Atlanta, Georgia.

10. **This Is Our Land,** by Cheyney and Schantz-Hansen; Webb Publishing Company, St. Paul, Minnesota.

11. **Soil, Earth's Living Layer,** Book II, Conservation Trails Series; Webb Publishing Company.

12. U.S. Department of Agriculture, Soil Conservation Service, Milwaukee, Wisc., or Washington, D.C. The following bulletins:

    M-286 – **What Is Soil Erosion?**
    M-394 – **Farms The Rain Can't Take**
    M-449 – **Early American Soil Conservationists**
    M-596 – **Our American Land, The Story of Its Abuse and Its Conservation**
    PA-71 – **Use The Land and Save The Soil**
    L-249 – **What Is a Conservation Farm Plan?, The Lord's Land, by Morris E. Fonda**

13. State Soil Conservation Committee, Executive Secretary, Natural Resources Bldg., Michigan State University, East Lansing, Michigan 48823, can supply bulletins on Soil and Water Conservation & Soil Conservation District organization.

14. The Michigan Dept. of Natural Resources, Lansing, can supply bulletins on this topic.

    Public Land In Michigan
    Life In The Soil

15. **Ours is the Land** by Allan A. Sollers, Holt, Rinehart & Winston, Inc.

Trees, Woodlots and Forests

FOR TEACHERS OR STUDENTS

1. **Behold Our Green Mansions,** by R.H.D. Boerker; University of North Carolina Press.

2. **The Great Forest,** by R.G. Lillard; Alfred A. Knopf, Inc.

3. **Forest Conservation Packets for Teachers,** supplied by U.S. Forest Service, and American Forest Products Industries, 1816 N. Street, N.W., Washington, D.C.
   Industries

   Both of these packets contain a teacher's manual, bibliographies, bulletins, and colorful wall charts. Free on request from either agency, but not from the Department of Natural Resources.

4. **Conserving Natural Resources,** by Shirley W. Allen; McGraw-Hill Book Co. (chapter IV).

5. **Burning An Empire,** by Stewart Nolbrook; The Macmillan Company.

6. **Conservation Handbook,** by National Association of Biology Teachers; Interstate Printers & Publishers.

7. **Conservation -- in the People's Hands,** by the American Association of School Administrators, published by the Amer. Assoc. of School Adm., 1201 16th St. N.W., Washington, D.C. 20036

8. **American Conservation In Picture and Story,** by Ovid Butler; American Forestry Association, 919 17th Street, N.W., Washington 6, D.C.

9. **High Timber,** by Charles I. Coombs; World Publishing Company.

10. Forest Service bulletins and visual aids available from the Office of Information, U.S. Department of Agriculture, Washington 25, D.C. Single copies are free to teachers, but some items may be out of print. Order by number and title.

    Bulletins
    F-1492 – **Arbor Day - Its Purpose and Its Observance**
    L-244 – **Community Forests for Rural People**
    M-162 – **Our Forests - What They Are and What They Mean To Us**
    M-249–**Careers In Forestry**
    M-290 – **The Work of the U.S. Forest Service**
    M-414 – **New Forest Frontiers** - Illustrated––30 cents
    M-543 – **Some Plain Facts About Forests**
    M-600 – **Water And Our Forests**
    PA-387 – **Forestry Activities for Boy Scout Leaders**
    AIS-34 – **Forestry and Jobs**
    AIS-67 – **Know Your Watersheds**
    AIS-130 – **Protecting Forests From Fire**

    SERVICE CHARTS
    D-4 – **How a Tree Grows** (16"x21" colored)
    D-5 – **What We Get From Trees** (27"x39" colored)

    MAPS
    V-1 – **Forest Trees and Forest Regions of the U.S.**
    V-2 – **National Forests of the U.S.**

11. Bulletins and circulars available from Michigan Department of Natural Resources. Free in limited quantities unless a price is indicated.

    Simple Key for Tree Identification
    Commercial Woods of Michigan and Their Uses
    Pine Days (illustrated logging history of Michigan)
    Motion Picture Catalog
    Wasteland
    State Forests at Work

12. **Biology** (textbook), by Kroeber, Wolff & Weaver; D.C. Heath & Company. (chapters 7, 8, and 25)

13. **A Field Guide to Trees and Shrubs,** by Geo. A. Petrides; Houghton-Mifflin Company.

14. **How To Know The Trees,** by Harry E. Jaques; Wm. C. Brown Company.

15. **Illustrated Guide to Trees and Shrubs,** by A.H. Graves; published by the author, Wellingford, Connecticut.

16. **Lumbering Era In Michigan,** a film strip; Audio-Visual Center, University of Michigan, Ann Arbor.

17. **Lumber** and other bulletins available from Lumber Manufacturers Ass'n., 1319 18th St., N.W., Washington, D.C.

18. **American Wildlife and Plants** - A guide to wildlife food habits; McGraw-Hill Book Co. Also in paperback from Dover Publications, Inc.

19. **Fruit Key and Twig Key to Trees and Shrubs,** by Wm. H. Harlow; Dover Publications, Inc.

20. **Our Plant Resources** by Fredrick S. Fitzpatrick, Holt, Rinehart & Winston

Fish and Wildlife

FOR TEACHERS OR STUDENTS

GENERAL, with excellent chapters on many phases of wildlife conservation and management.

1. **Our Wildlife Legacy,** by Durward L. Allen; Funk & Wagnall Company.

2. **Wildlife Conservation,** by Ira N. Gabrielson; The Macmillan Company.

3. **The Land and Wildlife,** by Edward H. Graham; The Oxford University Press.

4. **Field Book of Natural History,** by E.L. Palmer; McGraw-Hill Book Co.

5. **The Web of Life,** by John H. Storer; Devin-Adair Company.

6. **Fading Trails,** by D.B. Beard; The Macmillan Company.

7. **The Farmer and Wildlife,** by D.L. Allen; The Wildlife Management Institute, 709 Wire Building, Washington, D.C.

8. **Conservation Handbook,** edited by Richard L. Weaver for the National Association of Biology Teachers and the American Nature Association. A valuable reference for classroom and outdoor projects that have been tested in schools throughout the country.

9. **MNR Magazine,** Dept. of Natural Resources, contains articles on mammals, birds, fishes, and other natural resources. It is being sent free to all school libraries.

MAMMALS

10. **Michigan Wildlife Sketches,** of Bradt and Shafer, available from the Hillsdale Educational Publishers, P. O. Box 245, Hillsdale, Michigan for $1.20 which includes tax and handling.

11. **Our Animal Resources,** by Frederick L. Fitzpatrick; Holt, Rinehart & Winston, Co.

12. **Mammals of The Great Lakes Region,** by Wm. H. Burt; University of Michigan Press, Ann Arbor.

13. **A Guide to the Mammals,** by Wm. H. Burt; Houghton-Mifflin Company.

14. **Animal Homes,** by George F. Mason; Wm. Morrow & Company.

15. **Animal Tracks,** by George F. Mason; Wm. Morrow & Company.

16. **Tracks and Trailcraft,** by Ellsworth Jaeger; The Macmillan Company.

17. **Game and Wild Fur Production and Utilization on Agricultural Land,** Circular No. 636, U.S. Fish and Wildlife Service, Washington, D.C.

18. **Lives of Game Animals,** by E.T. Seton (4 or 8 volumes). Available in city and university libraries.

BIRDS

19. **Enjoying Michigan Birds**; Michigan Audubon Society Bookshop, Kalamazoo College, Kalamazoo, Michigan.

20. **A Book of Bird Life,** by A.A. Allen; D. Van Nostrand Company.

21. **Birds of Prey of Eastern North America,** by L.A. Housman; Rutgers University Press, New Brunswick, N.J.

22. **Food Habits of Common Hawks,** Circular No. 370, U.S. Department of Agriculture, Washington, D.C.

23. **What Hawks Eat**; National Audubon Society, 1130 Fifth Ave., New York.

24. **Ducks, Geese, and Swans of North America,** by F.H. Kortright, Wildlife Management Institute, 709 Wire Bldg., Washington, D.C.

25. **How to Attract Birds,** by R.S. Lemmon; Doubleday & Company.

26. **Field Guide to the Birds,** by Roger T. Peterson; Houghton-Mifflin Co.

27. **Something About Birds;** Michigan Department of Natural Resources, Lansing.

FISHES

28. **Northern Fishes,** by Samuel Eddy & Thaddeus Thurber; University of Minnesota Press; Minneapolis.

29. **Environmental Conservation,** by R.F. Dasmann; John Wiley & Sons (chapt 9)

30. **Fish and Fishing in Michigan,** by Karl F. Lagler; Follett's Book Store, Ann Arbor.

31. **Fish and Conservation Fundamentals,** by R.W. Eschmeyer; Sports Fishing Institute, Bond Bldg., Washington, D.C.

32. **Fishes, A Guide to Familiar American Species,** by Zinn and Shoemaker; Simon & Shuster.

33. The Department of Natural Resources, Lansing, publishes many pamphlets on fish.

No. 8 – **The Smelt**
No. 12 – **Michigan Fish Predators**
No. 13 – **Problems in Trout Management**

No. 19 – **Eradication of Fish by Chemical Treatment**
No. 22 – **Names of Michigan Fishes**
No. 23–**Some Historical Aspects of the Carp**
No. 25 – **Eradication of Algae with Chemicals**
No. 26 – **Age and Growth of Fish in Michigan**
No. 31 – **The Bluegill in Michigan**
No. 35 – **The Lake Sturgeon, – Fishing in Michigan**

34. **MNR Magazine,** articles on fish and fish management in previously published issues. Copies for prior years usually available in school and public libraries.